A short memo on the status of HZZ (IHEP)

06/11/2019

1. Higgs->Z(->νν)Z*(–>qq)

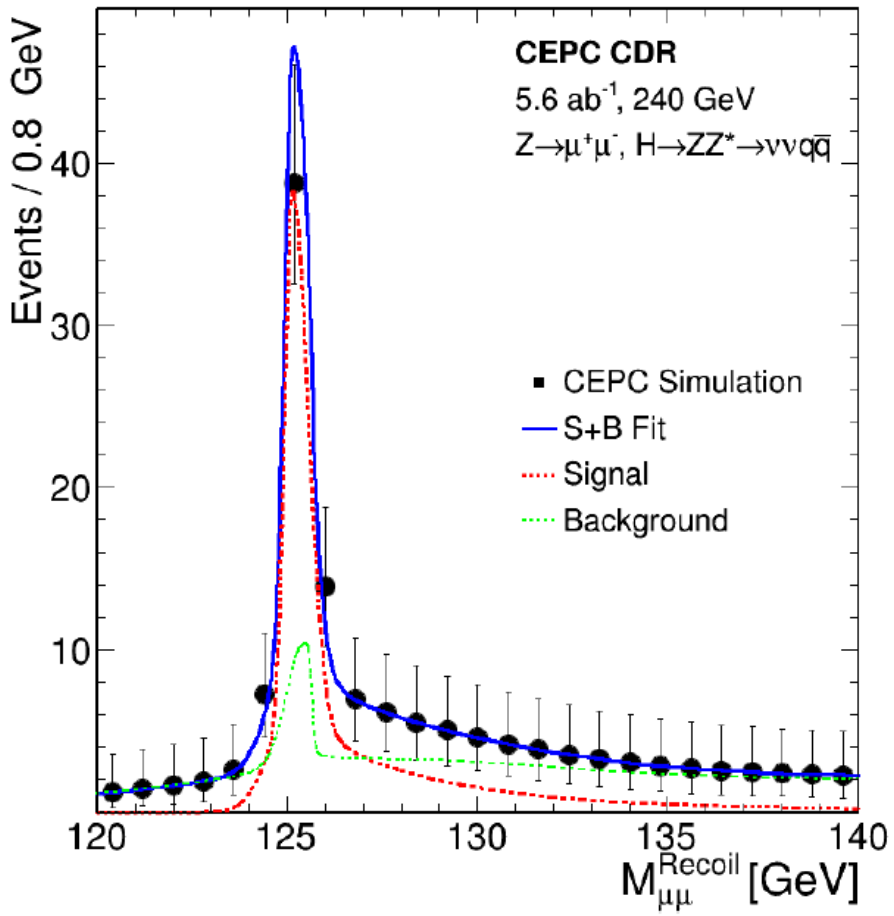


Figure 18: *vvjjfit*

Table 5: $e^+e^- \rightarrow \mu^+\mu^- H\_\nu\nu jj$ cuts information

cut	signal	zh background	2f background	4f background
Raw events	1212	12557950	8828594187	1180400980
$Pre-selection$	817	31794	4170834	735206
$Signal\ or\ not$	270	31571	4170834	735206
$M_{miss} > M_{dijets}$	138	2132	1945599	240838
$80GeV < M_{\mu^+\mu^-} < 100GeV$	127	1254	1338593	48117
$120GeV < M_{Recoil} < 150GeV$	126	1227	152297	15384
$15 < N_{pfo}$	125	506	5953	760
$10GeV < Pt_{visible}$	118	462	783	321
$Min\ angle > 17.2°$	109	429	582	194
$M_{miss} > 80GeV, M_{dijets} < 35GeV$	79	90	553	78
$Pt_{jet1,2} > 3GeV, E_{jet1,2} > 5GeV$	68	72	0	8

Table 6: $e^+e^- \rightarrow \mu^+\mu^- H\_\nu\nu jj$ main final backgrounds (¿10) left

name	scale	final
e2e2h_ww	0.0818403	12
nnh_zz	0.0683871	55

From Lingteng' internal memo

2. Higgs->Z(->qq)Z*(->νν)

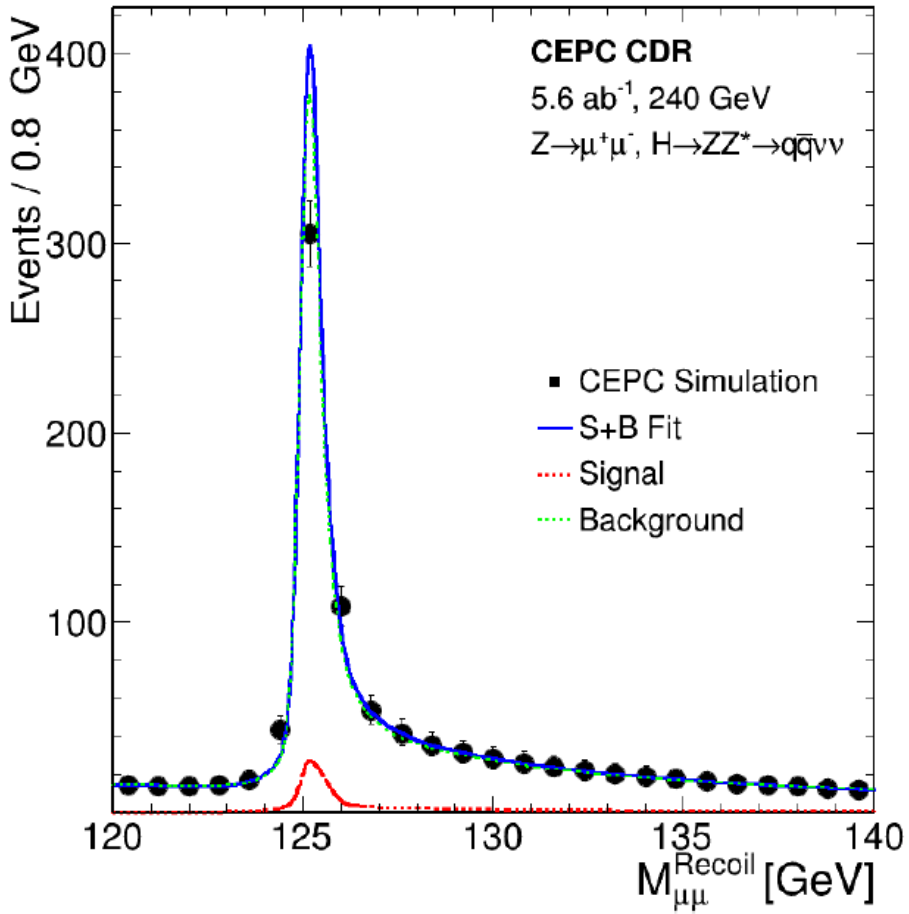


Figure 20: *jjvvfit*

Table 7: $e^+e^- \to \mu^+\mu^- H\_\nu\nu jj$ cuts information

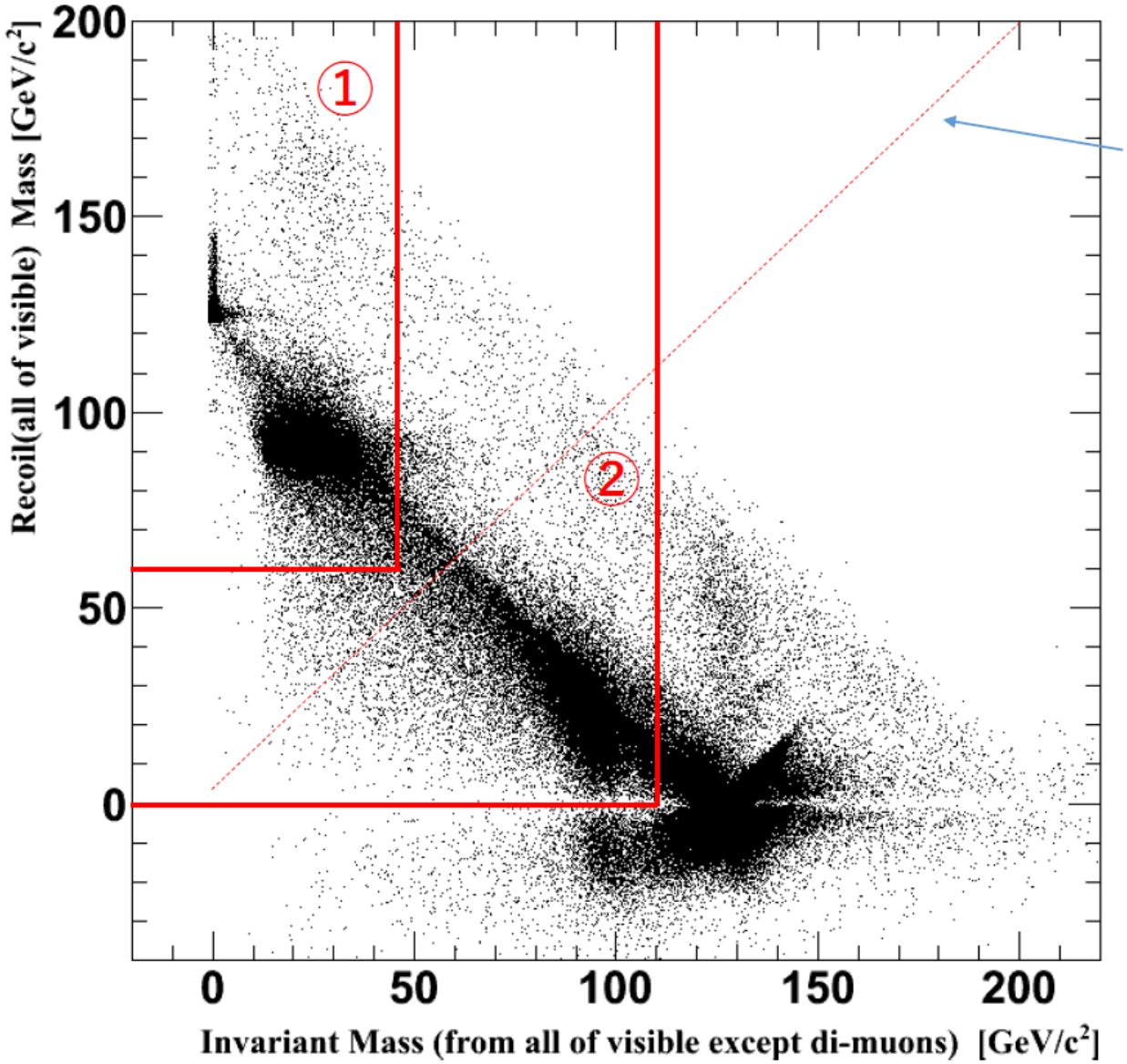
cut	signal	zh background	2f background	4f background
Raw events	1266	12557950	8828594187	1180400980
$Pre-selection$	854	31794	4170834	735206
$Signal\ or\ not$	282	31571	4170834	735206
$M_{miss} > M_{dijets}$	138	29438	2225234	494368
$80GeV < M_{\mu^+\mu^-} < 100GeV$	126	24273	1543274	250618
$120GeV < M_{Recoil} < 150GeV$	125	24159	93570	22035
$30 < N_{pfo}$	122	18136	321	18956
$10GeV < Pt_{visible} < 50GeV$	100	4612	59	1636
$17.2° < Min\ angle < 90°$	94	4352	59	1422
$M_{miss}M_{dijets}$	59	850	0	308
$Single\ jet$	52	706	0	283

Table 8: $e^+e^- \to \mu^+\mu^- H\_jj\nu\nu$ main final backgrounds (¿10) left

name	scale	final
e2e2h_bb	0.21917505	436
e2e2h_ww	0.0818403	202
qqh_e3e3	0.48487575	16
qqh_zz	0.20235855	33
zz_sl0mu_up	1.09139300069	60
zz_sl0mu_down	1.08131822774	207

From Lingteng' internal memo

Reference： Invariant Mass (ZZ*) vs Missing Mass



Missing Mass (Z->νν) = Dijet Mass (Z->qq)

1. H->ZZ*->ννqq
   - -- Missing M > Dijet Invariant M
   - -- Missing M > 60 GeV
   - -- Dijet Invariant M < 45 GeV
2. H->ZZ*->qqνν
   - -- Missing M < Dijet Invariant M
   - -- Missing M > 0 GeV
   - -- Dijet Invariant M < 110 GeV

Precision

"hjjvv" has much worse precision

Combined results is very same level as only "hvvjj"

can we reduce it a bit by improving "hjjvv" precision ?

From Lingteng' internal memo

Precision of Branch ratio of Higgs to ZZ is

For hvvjj 11.2%

For hjjvv 40.3%

Combine results of Precision of Branch ratio of Higgs to ZZ is

10.6%

Equations used for calculation of precision of Higgs width:

$$\Gamma_H = \frac{\Gamma_{H->ZZ^*}}{Br_{H->ZZ^*}} \propto \frac{\sigma_{ZH}}{Br_{H->ZZ^*}}$$

$$Precision\ of\ \Gamma_H : \frac{\Delta\Gamma_H}{\Gamma_H} = \sqrt{(\frac{\Delta\sigma_{ZH}}{\sigma_{ZH}})^2 + (\frac{\Delta Br_{H->ZZ^*}}{Br_{H->ZZ^*}})^2}$$

Precision of Higgs width is

For hvvjj 11.2%

For hjjvv 40.3%

Combine results of Precision of Higgs width is

10.6%

Consideration after Lingnteng's work

1. For, Higgs->ZZ* (vvjj) channel, the main bg. seems to be Z->vv, Higgs->ZZ* . If that is the case, how we can treat the correlation ?

For that, would be worth to analyze both channels under similar analysis condition.

2. For, Higgs->ZZ* (jjvv) channel, how much we can suppress the background, by introducing such as MVA etc.

Consideration after Lingnteng's work

3. Cover the other channels (for example, Z->ee, Higgs->ZZ*)

表 5.1 H->ZZ*衰变末态中已分析的衰变末态汇总（绿色单元表示该衰变道的测量精度> 20%）

Z\ ZZ*				
e^+e^-	ννjj	jjνν		
$\mu^+\mu^-$	ννjj	jjνν		jjjj
νν	e^+e^-jj	jje^+e^-	$\mu^+\mu^-$jj	jj$\mu^+\mu^-$
jj	e^+e^-νν	ννe^+e^-	$\mu^+\mu^-$νν	νν $\mu^+\mu^-$

统计误差 >20%的衰变道的统计结果如下

表 5.2 H->ZZ*所有衰变末态中统计误差 >20%的衰变道的统计结果

	信号事例数	信号效率	统计误差
e^+e^- ννjj	65±8	50.1%	15.1%
$\mu^+\mu^-$ννjj	88±9	67.3%	12.0%
νν e^+e^- jj	43±7	27.6%	18.6%
νν $\mu^+\mu^-$jj	90±9	57.4%	11.4%
νν jj $\mu^+\mu^-$	77±8	49.7%	12.9%

from Wei Yuquan's thesis

Resolving the tensor structure of the Higgs coupling to Z-bosons via Higgs-strahlung

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We propose differential observables for $pp \to Z(\ell^+\ell^-)h(bb)$ that can be used to completely determine the tensor structure of the $hZZ^*/hZ\bar{f}f$ couplings relevant to this process in the dimension-6 SMEFT. In particular, we propose a strategy to probe the anomalous $hZ_{\mu\nu}Z^{\mu\nu}$ and $hZ_{\mu\nu}\tilde{Z}^{\mu\nu}$ vertices at the percent level. We show that this can achieved by resurrecting the interference term between the transverse Zh amplitude, which receives contributions from the above couplings, and the dominant SM longitudinal amplitude. These contributions are hard to isolate without a knowledge of the analytical amplitude, as they vanish unless the process is studied differentially in three different angular variables at the level of the Z-decay products. By also including the differential distributions with respect to energy variables, we obtain projected bounds for the two other tensor structures of the Higgs coupling to Z-bosons.

based on an EFT model, can we say something together with our HZZ results ?